

Vol. X. No. 9.

September 15, 1913

THE
PSYCHOLOGICAL BULLETIN

GENERAL REVIEWS AND SUMMARIES

MEMORY, IMAGINATION, LEARNING, AND THE
HIGHER MENTAL PROCESSES
(EXPERIMENTAL)¹

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I. MEMORY AND IMAGINATION

(a) *General Questions.*—Jesinghaus (25) undertook to determine which method of memorial investigation affords the clearest insight into memorial dispositions and their interrelations. He found that the recognition-method reveals the existence of dispositions of such slight intensity that they escape observation when other methods are employed; and the observer's descriptions of his feelings of familiarity enable one to differentiate several degrees of intensity of disposition. A combination of the methods of recognition and reproduction is recommended. Fischer (15) reports a confirmation of his earlier conclusion that an intimate relationship obtains between the memorial dispositions which constitute the basis of recognition and those which give rise to reproduction; but G. E. Müller's paper (36) indicates the existence of a different state of affairs. Müller introduced distractions immediately after certain acts of learning; the reproduction-method showed that the non-distracted data were much more completely remembered than the distracted data, while the recognition-method gave approximately identical results in the two cases. This seems to justify the infer-

¹ The writer is indebted for aid in the preparation of this summary to Dr. S. C. Fisher and Dr. S. W. Fernberger, of Clark University. Three monographs which appeared during the year have not been accessible; and certain papers of which only the first instalments have been published are not included on account of lack of space.

ence that recognition does not demand the presence of effective associations,—an inference which is supported by Gregor's finding that, in Korsakoff's disease, no parallelism is to be found between disturbances of recognition and disturbances of reproduction. Poppelreuter (43) points out that no investigation can disclose the elementary laws of association and reproduction in pure form if it employs a method in which processes of volition and thinking play a part. In his own experiments, he employed the *Treffermethode* with the usual instructions ("Name the other syllable of the same rhythmic group"), and with free instructions ("Describe what comes to consciousness when the syllable is presented"). His results show that associations are profoundly influenced by the participation of will; the assigning of a circumscribed *Aufgabe* may result in a threefold increase of the number of correct reproductions. It should be the aim of the investigator to find an explanation of the phenomena of association and reproduction, not by having recourse to such factors as volition and apperception which regulate and govern associations, but by referring them to certain definite elementary laws of association.

Michotte and Ransy (35) undertook to determine what rôle is played by strictly intellectual processes in the remembering of logically related data. They found that reproductions may be direct or indirect,—the remembrance being mediated in the latter case by an intermediary process. The intermediary may be concrete or verbal ideas of various sorts, affective processes, or *Bewusstheiten* relating to the relation between the presented data. Consciousness of relation was reported in 45 per cent. of the cases. It frequently assumed an intentional form where it determined the coming word, the latter being described as "that which was to come," "that which I was waiting for;" it was present in this form from the instant when the observer apprehended the stimulus-word and set out to accomplish the task of finding a related word. The consciousness of relation appeared in various forms: as a simple remembrance of the identity or opposition, etc., between the original pair of words; as an imageless knowing; in rare instances, as a "thought." Whether accompanied by a sensory symbol or not, it appeared in certain cases to be a mere accessory to the act of reproduction; but in other instances it proved to be an effective factor where it defined the reaction-word in relation to the stimulus-word.

Schöneberger (46) traces the evolution of the experimental

investigation of memory and presents certain of the more important findings. He emphasizes the pedagogical point of view throughout and ignores the results of pathological investigations. Hentschel (22) presented digits, consonants, groups of consonants, nonsense-syllables, and words to a number of children, in an attempt to determine the compass of immediate reproduction. His observers included thirty-one backward children between the ages of eight and fourteen (degree of mental retardation not specified), and twenty-four normal children between the ages of six and thirteen years. He finds that a lesser capacity of immediate reproduction is usually associated with a lesser degree of intelligence; and he is of the opinion that this phenomenon may constitute a test of intelligence. Vértes (52) attempted to determine what correlation obtains between memorial capacity on the one hand, and age, sex, intelligence, and social *milieu* on the other; between compass and promptness of memory; between memorial capacity and permanence of retention. He found a positive correlation between intelligence and memory and between age and memory; between promptness of reproduction on the one hand, and age, intelligence and compass of memory, on the other. The memorial capacity of girls is superior to that of boys; and that of children of well-to-do parents is superior to that of children of poor parents.

Hollingworth (23) undertook to determine the effect of caffeine upon a wide range of mental and motor processes. His results show that the effects of caffeine are constant and uniform, varying somewhat with the size of the dose, with the body-weight of the patient, and with the sort of efficiency tested. Its effect upon motor processes is relatively prompt and transient; upon the higher mental processes, more slow and more persistent. The general effect was stimulative; but in certain instances the nature of the effect varied with the size of the dose,—small doses giving rise to retardation, moderate doses having no effect, and large doses producing a stimulation, in the case of motor coöordinations; while in the case of discrimination reactions, these relations were reversed. Secondary effects were wholly lacking. Hollingworth's second paper (24) reports that the act of typewriting is accelerated by small doses of caffeine (one to three grains), but retarded by larger doses (four to six grains); accuracy is improved by both small and large doses, up to six grains.

A consideration of the literature of correlation has convinced Hart and Spearman (19, 20) that the present lack of agreement

regarding correlation between different intellectual functions is due to gross misinterpretation. The available evidence indicates that correlation is due to the fact that all of the performances, however different, depend in part upon a common general factor. This general factor is not a specific process, nor does attention furnish an adequate explanation; the presence of correlation between intellectual performances seems to be traceable to the fact that every such performance inhibits the simultaneous performance of activities of a different sort. This leads to the assumption that every performance draws upon a common fund of energy; and this common fund of energy constitutes the basis of the required general factor. Every mental process depends not only upon this general factor, but also, in varying degree, upon a specific factor which is peculiar to this and to all other similar activities. Expressed in physiological terms, every intellectual activity involves not only the specific activity of a particular system of neurones, but it also involves the general energy of the whole cortex.

(b) *Imagery*.—Miss Fernald (14) has made a study of ideational types, and of the best means of determining the type to which a given individual belongs. Her procedure consisted essentially in making a detailed examination of the imagery employed by eleven trained observers in different situations and under different circumstances. She distinguishes a versatile type which is characterized by proficiency in the use of visual-auditory and vocal-motor imagery, and a type which possesses certain favored sorts of imagery in addition to verbal images which are always present. No test can be devised which enables one to make a purely objective diagnosis of mental imagery; but certain objective procedures, when supplemented by introspection, are adapted for detecting the presence and the functioning of the various sorts of imagery. Miss Downey (13) made a study of the imagery employed in representing the self. Selections of poetry were presented either in auditory or in visual fashion to fourteen observers, who then described their experiences in so far as concerned their own orientation in relation to the imagined scene, their felt postures and movements, their organic identification with the persons and objects described, their visual and auditory references to the self, and the like. A marked individual variation appears in the frequency with which an explicit reference to the self is reported, ranging between 19 per cent. and 62 per cent. The act of self-projection may assume various forms: a relatively pure visual form, a relatively pure kinæsthetic

form, a rare auditory form, a cutaneous form, and various forms which are characterized either by an alternation or by a combination of imagery from different modalities. In the experiments of Miss Chapin and Miss Washburn (10) one hundred and ninety-three students were asked to describe the images which they employed to represent the idea "meaning." The imagery reported was either wholly visual, wholly kinæsthetic, or a combination of visual and kinæsthetic; and in almost every instance, the relevant character of the imagery was evident. The imagined movements had to do with groping, grasping, pointing, delving, gazing, and the like; the visual images represented a page of the dictionary with the reader leaning over it, a hand pointing to a word, words connected by a sign of equality, something unfolded, and the like.

Brahn (7) reports the results of an experimental diagnosis of the memory of a mathematical prodigy (Dr. Rückle). It was found that Rückle's ideational type is dominantly visual; but he employs auditory-motor in addition to visual imagery when certain sorts of material are presented, and when material which is presented in auditory fashion can not readily be transformed into visual imagery. Neither vocal nor digital movements were made save in rare cases, but eye-movements seemed to be of significance. Rückle never learned digits in isolation; he usually preferred to combine them into groups of six, but groups of five and seven were also frequent. He made extensive use of numerical relations; 624 was remembered as the square of 25 less one; 26,169 was remembered because 26 is twice 13, and 169 is the square of 13, etc. Rückle is characterized by a keen and vigorous attention and by an extremely rapid apprehension; his wide experience enables him to systematize his act of learning.

Miss Martin (31, 32, 33) has investigated the familiar phenomenon that normal individuals sometimes project their visual images into external space. She determined the temporal relations, and the characteristics of the projected image, and its relation to attention, emotion, and association; she aimed to discover the differences between perception, image and after-image, and between the image of memory and the image of imagination. And the investigation was extended to include auditory and vocal-motor images, and the imagery of abnormal patients. Most observers succeeded in projecting their visual images, and most of them found that the image appeared more readily with closed than with open eyes. Certain definite similarities but also certain marked dis-

similarities between images of memory and images of imagination are reported. The author points out that her method is capable of wide employment in psychological experimentation. G. E. Müller (37) has been led, by his memorial investigations and by a study of number-forms and chromæsthesias, to differentiate four types of localization of visual imagery,—subjective and objective factors being variously combined in the four cases.

(c) *Association*.—Wells (53) returns to the question of association types, where an analysis of 10,900 reactions by twenty-eight normal adults confirms his former finding that a certain range of reaction-time seems to be a typical phenomenon. Fidelity to type appears in a tendency toward predicate, subordinate, contrast and internal-objective responses, but not in speech-habit reactions. He finds an indication of a pronounced negative correlation between egocentric category and community of response. Culler's investigation (11) deals with the phenomenon of associative interference, and with individual differences of adaptability in overcoming this interference. He trained his observers to react to certain stimuli with certain movements; and after these associations had become well established by practice, he trained them to react to the same stimuli with other movements; he also had them sort cards alternately into a different arrangement of compartments at alternate sittings. He found that opposing associations interfere with one another in all observers, and that the interference decreases in amount as practice in the new association becomes greater, until finally both give rise to appropriate reactions in wholly automatic fashion. The interference may reveal itself either in a lengthened reaction-time or in an actual recurrence of the former reaction. Individual differences are greater under the modified instructions than in the original, less complex reactions. The reagent who is most efficient at the outset shows quite as much improvement during the process of mechanization as does the less efficient reagent. Miss Atherton and Miss Washburn (3) employed a method which consisted in presenting a word to which the observer was instructed to respond by a reaction-word which had no associative connection with the stimulus-word. These instructions furnish an obstacle to the functioning of the mental processes which would otherwise be in operation; and the question arises as to the nature of those processes which function in spite of the obstacle. These were found to contain mediate associations, or ideas which are connected with the stimulus-word by an intermediate process which has no

conscious concomitants. Wohlgemuth (54) discusses the question as to the justification of the current view that associations tend chiefly in a forward direction. Colors, figures and nonsense-syllables were presented either in pairs or in continuous series. The results show that association may function in a backward as well as in a forward direction; and the author believes that when associations are pure (non-kinæsthetic), they operate quite as frequently in a backward as in a forward direction. Poppelreuter (42) believes that the basis of reproduction is to be found not in the perceptual datum but in the "secondary experience" or the total idea which attends or immediately follows the perception. The reproduction-tendency proceeds directly from the reproduction-motive to the whole of the total idea, and not from part to part as has been assumed. To reproduce means to explicate the parts of a total idea,—the order in which the parts are successively explicated being determined not by their serial order in perception, but by their relative degrees of intensity in consciousness.

(d) *Learning and Forgetting*.—Meumann (34) calls attention to the fact that the effect of the act of learning varies, in highly differentiated fashion, with the specific intention of the learner. Many incidents of everyday experience are forgotten because we have not intended to remember them, or because we have intended to remember them only so long as serves our purpose. In the experimental investigation of memory, we find that when the learner's intention is artificially turned in a specific direction by the experimenter's instructions, the learner fails to note and remember that which does not lie in that specific direction. For instance, when a learner has been instructed to memorize a list of syllables by reading them in trochaic rhythm, and when he expects that his memory will be tested by means of the *Treffermethode*, he assumes a highly differentiated attitude toward his act of learning. It may turn out that he is unable subsequently to reproduce or even to recognize, the accented syllables; but when they are presented to him by the experimenter he can recall their unaccented mates without error. This paradoxical state of affairs shows that one's intentional learning may proceed in iambic rhythm while one's vocalization follows a prescribed trochaic rhythm. Aall (1) investigated the influence of "temporal perspective" upon the act of learning. Stories and numbers were presented to groups of children. In one case the children were led to expect that their remembrance would be tested on the following day; in another case

they were told that the test would be deferred for several weeks. In both cases the test was actually deferred for several weeks; and the results show that the material was much less completely remembered in the case where the learner expected that the test would take place in the near future. Strong (49) investigated the effect of length of series upon immediate reproduction. Advertisements were presented visually in series of five, ten, twenty-five, fifty, one hundred, and one hundred and fifty; and remembrance was tested immediately afterwards by the recognition-method. It was found that the correct recognitions decreased from 86 per cent. in the series of five, to 47 per cent. in the series of one hundred and fifty,—the percentage of uncertain and erroneous recognitions increasing as the series became longer.

Nagel's investigation (40) consisted, in part, in having his observers learn and relearn series of nonsense-syllables, with the significant variation of method that in certain cases the syllables which constituted a series were presented in a transposed order for the act of relearning. This procedure enabled the investigator to determine the relative significance of identity of data and identity of serial order of data in an act of relearning; and a systematic variation of degree and kind of transposition enabled him to differentiate the significance of such factors as sequence within the series, and absolute position in the series. The procedure in this group of experiments also included variations in the length of interval between learning and relearning, and variations in the degree of thoroughness of learning,—all of which yielded a detailed analysis and a quantitative determination of the factors which contribute to the act of learning. Nagel's investigation also dealt with the relative value of each number of a series of presentations, in rational as well as in mechanical learning; with the effect of various distributions of repetitions; with the differences between the learning of significant and non-significant materials; with the alleged phenomenon of mediate association; with the phenomenon of "total impression" in the act of learning; and with the general problem of methods of memorial investigation. His results are so numerous that they can not be summarized in the space at the disposal of the present reviewer; the reader is referred to the author's own presentation of this exceedingly valuable paper.

In an investigation of the relative effect of various modes of presentation, Kline (26) found that interference with the dominant receptor mechanism results in a more serious impairment of the

process of learning than does interference with the preferred form of expression. Henmon (21) reports the remarkable result that the auditory mode of presentation was most advantageous for all of his observers (of mixed type) and for every sort of material which he employed (nouns, numbers, nonsense-syllables),—a result which he refers to the fact that auditory presentation makes a stronger appeal to the learner's attention, and that it facilitates visualization. Frankfurter and Thiele (17) find that the sort of imagery which appears in an act of reproduction is determined primarily by the ideational type of the individual, and that it is influenced only in subordinate degree by the mode of presentation. Auditory presentation proves to be more advantageous in the case of auditory learners; but the averages of the results obtained by these investigators show that a combined visual-auditory-vocal mode of presentation is by far the most effective. They conclude that the optimal mode of presentation varies with the ideational type of the learner.

Alford (2) reports the familiar phenomenon that the initial and final sections of a series of (relatively uniform) data are more easily learned than the central section; and Dell (12) finds, naturally enough, that this does not hold in cases where the various items of the series represent widely different degrees of complexity of content and difficulty of acquisition. The results of Bean's study of the rate of forgetting (5) furnish "no warrant for altering the general character of the Ebbinghaus curve of forgetting."

In Norsworthy's study (41) of the relation between rapidity of acquisition and permanence of retention it was found that the most rapid learners were able to recall 76 per cent. and the slowest learners only 46 per cent., in immediate reproduction; in delayed recall, a month later, the difference in favor of the rapid learners was even greater, the figures here being 78 per cent. and 36 per cent. Starch (48) undertook to discover whether the superior advantage of distributed over accumulated repetitions holds in the case of materials other than nonsense-syllables, and whether it holds for long-continued acts of learning. His act of learning consisted in establishing an association between numbers and letters; and his distributions of learning-time varied between twelve periods of ten minutes each and a single period of one hundred and twenty minutes. His records show that learning proceeds more rapidly, the shorter and more numerous the learning-periods are. This result is referred by the author to the presence of a higher degree of concentration

throughout the shorter periods, and to the fact that associations tend to become more firmly fixed during a subsequent period of rest.

Krämer's investigation (28) aimed to throw light especially upon the phenomenon of "corner-stones" which constitute the foundation for the process of acquisition in the learning of significant material. He employed selections of philosophical, descriptive, and narrative prose. His method consisted in instructing his learners to devote their attention now to the meaning alone, now to the form of expression alone, and now to both in equal degree; and in interrupting the learners at intervals in order to determine the order in which the several parts of the text were mastered. The author shows the significance of *Einstellung* in the act of learning; he enumerates the various differences in form of expression which constitute aids and hindrances to learning; and he differentiates and describes four stages through which the act of rational learning passes. An appendix by Meumann discusses methods of investigating the memorization of significant materials, the significance of attitudes in learning, and certain general questions which bear upon the psychology of memory.

Miss Woods (55) has summarized the recent literature of memorization, and Richardson (44) has published a similar summary dealing with the acquisition of skill.

II. INTELLECTUAL PROCESSES

Titchener (51) points out that in recent investigations of the higher mental processes introspective reports contain materials of wholly different sorts: introspective descriptions, and statements of meaning. In the former case, the introspector has undertaken the task of observing and analyzing his continuum of mental processes; in the latter case, his *Aufgabe* consists in stating the meanings which prove on reflection to be implicit in certain moments of the continuum. The former *Aufgabe* alone is psychological; the latter is logical.

Külpe (29, 30) discusses the present status of the problems of the higher mental processes, and indicates an interpretation of the results. An envisagement which limits the content of mind to sensations, ideas, and feelings, is inadequate. The *Bewusstseinslage* and the *Bewusstheit*, which must be added to the traditional components, have to do chiefly with relations and subjective activities by means of which we take up an attitude toward the specific

contents of consciousness. The discovery of the *Aufgabe* and of the *determinierende Tendenz* free us still more completely from the fetters of sensationalism and associationalism. These recent findings are significant not only for psychology, but also for logic, epistemology, aesthetics, and pedagogy.

Selz (47) holds that the *determinierte* consciousness consists in a transposition of the adequate and indirect determination of an internal process into the process itself, by means of a schematic consciousness of a relation. The determination of the indirectly determined goal brings about an actualization of certain complex mental processes which are appropriate to the momentary character of the total *Aufgabe*,—which may be designated by the general term "methods of solution." Koffka (27) found that the choice of reaction-word does not depend exclusively upon the instructions, but is a product in part of the reagent's habitual associations, and of *Einstellungen* which may operate in either a positive or a negative fashion. The transition from the stimulus-idea to the reaction-idea may be mediated by *Gedanken*; these may thrust themselves into the train of ideas and hence they may produce a dynamic effect as determinants. Ideas, therefore, are not of paramount significance; it is thoughts which give rise to determining tendencies, and it is these latter which ideas must obey. Ideas however may, in consequence of their intensive perseverative or associative tendencies, succeed in blocking the operation of the *determinierende Tendenz*. The factors which determine the appearance and the flow of ideas are exceedingly numerous; there are *determinierende Tendenzen* which proceed directly from specific *Aufgaben*, while others possess universal significance both for the individual reagent and for thinking in general. Other determining tendencies are due not to volition but to *latente Einstellungen*. These latter appear involuntarily, and the reagent may be wholly unaware of their existence and operation. Their effect upon the stream of ideas may be direct, or it may be indirect, through the production of new determining tendencies which in turn may have a direct effect upon the stream of ideas. The relation between *determinierende Tendenzen* and associative tendencies is not one of simple opposition; the determination is rather to be regarded as an influence which is superimposed upon the association,—facilitating it and directing it, although the effect may also be inhibitory.

In an investigation of the concept-consciousness, Aveling (4) endeavored to induce an association between nonsense-words and

meanings; he subsequently endeavored to investigate the functioning, in simple judgments, of these words with their acquired meanings. He emphatically affirms the presence of abstract and imageless concepts between which the important associations in thought obtain, imagery being a mere by-product in these processes. He holds that universal meanings tend to appear in consciousness as pure concepts, and particular meanings in the form of images; and he maintains that a conceptual knowledge of universality or particularity of reference is present in both universal and particular meanings. Grünbaum (18) finds that the act of reflection, whether present in relatively passive or relatively active form, possesses three criteria: internal tension, anticipation of the idea sought for, expectation of that idea. In the act of reflection an idea presses forward into the sphere of meaning, and the sphere of meaning becomes more narrow and more concrete. Reflection itself is nothing more than progress from a lower stage of many associated meanings, through a stage of ideas of isolated meaning, to the genuine reproduction of the only idea which is appropriate.

Müller-Freienfels (38) differentiates three forms of non-verbal thinking: (a) *undersprachlich*, consisting in mere non-sensory attitudes,—illustrated in the thinking of animals and children, and in such adult acts as the spontaneous investigation of the cause of an unexpected noise; (b) *nebensprachlich*, a form not essentially different from verbal thinking,—illustrated in the digital communication of the blind; (c) *übersprachlich*, thought which is too complex and too rapid for adequate verbal formulation, although it may be accompanied by fragments of words or phrases. In a second paper (39) he contends that sensory reproduction has been overestimated in so far as its significance for the act of knowing is concerned. Biologically, the sole significance possessed by ideas consists in the production of non-concrete thoughts, which the author calls *Einstellungen*. These may be described as our attitudes toward our mental contents; they are essentially motor phenomena. Strong and Hollingworth (50) find that judgments regarding contents which are grammatically and logically opposed are not merely the positive and the negative phases of the same act; they involve mental processes and criteria which are not identical. With increasing practice in judging, however, the processes and criteria become more and more alike and the two types of judgment tend to coincide. Miss Fisher's paper (16) is a summary of the recent literature which deals with reasoning in children. Bühler

(8) found that the child's capacity to abstract improves regularly with increase in age up to about the age of nine or ten, where a retardation appears. Variation of this capacity with degree of intelligence is so constant that the abstraction experiment may be employed as a test of intelligence.

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MEMORY, CONCEPT, JUDGMENT, LOGIC (THEORY)

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The conflict between the more habitual and fixed methods of thought and the more plastic adaptations of thinking to new and changing conditions appears in various forms in current studies and discussions of logic and of kindred subjects. Formal logic reasserts itself in Coffey's work (2) which is given over to a full and official exposition of traditional logic with the object of showing how it furnishes the true basis for modern methods of scientific investigation, inductive no less than deductive, and with the object as well of extending its range by applying it to some logical problems raised in more recent times. A most thoroughgoing instance of intellectual protestantism, on the other hand, is the equally explicit and compendious treatment accorded to formal logic by Schiller (14). The fundamental position taken by Schiller is that "it is not possible to abstract from the actual use of the logical material and to consider 'forms of thought' in themselves, without incurring thereby a total loss, not only of truth but also of

meaning." Formal logic is vitiated *ab initio* by this paralyzing, soul-devastating abstraction. And symbolic logic is indeed the same thing, only more so, though it is clear-headed enough not to endorse all of its untenable claims about the real validity of its results. In relevancy (17) not in abstraction lies the whole difference of principle between voluntaristic and intellectualistic conceptions of knowledge. Criticisms of Schiller's book have caused him to define certain aspects of his position further in (15) and (16).

The controversy between Poincaré (11, 12) and Couturat (1) centers about the question as to whether mathematical thinking is guided by intuition, "sure instinct," the "logic of nature and of life," in which logical principles are still in the making, or whether it moves within preordained logical conditions or logical constants. Couturat holds that the freedom of mathematical invention is illusory. The "sure instinct," the "more profound geometry," which guide the discoverer are only unconscious forms of logical reason. The reason which invents is conformable to, and at bottom identical with, the reason which demonstrates, which verifies. Poincaré objects to logistics on the ground that it restricts intelligence to a limited arsenal of rules posited beforehand, instead of leaving it free to invent new ones. Couturat rejoins that intelligence may never invent new rules but it may discover them. Poincaré objects further that logistics has so far proved barren of results for either mathematics or logic. Logistics reduces to an immense tautology or else engenders antinomies. It remains sterile unless fructified by intuition. Poincaré interprets Russell as leaning finally towards a no-class theory which sounds the knell of the old logistic.

Padoa (10), a disciple of Peano, has completed the publication of a series of lectures delivered under the auspices of the University of Geneva in exposition and defense of symbolic logic, preceded by a brief historical statement and an answer to objections. Padoa takes the position that symbolic logic is essentially an instrument of thought indispensable to the representation of concepts which on account of their subtlety escape precise determination in ordinary language. It does not create ideas but it reveals them microscopically, so to speak, to the eye of the mind.

Lewis (7) criticizes the use of implication in algebraic logic, as in the phrase " p implies q ," advocating a discrimination expressed in terms of different symbols of the two types of disjunction involved.

Hicks (4) offers a sharp criticism of the use of Euler's circles, except for demonstrating simple and obvious relationships. Anything beyond this severe simplicity is open to two objections: (1) the figures by reason of their complexity hinder rather than help; (2) modern refinements of the Eulerian method, especially its extension into adjacent space to represent contradictories, may not only blind one to fallacies already latent, but may also breed fresh fallacies. The same author (5) also contends that inversion is not a valid inference, holding that it violates the fundamental principle of logic and common sense that we should not go beyond the evidence. Schmidt (18) takes issue with this conclusion, undertaking to prove in symbolic terms that under certain conditions inversion is valid. Hick's rejoinder (6) raises the question as to the legitimacy of ignoring the radical qualitative difference between mathematical units and logical units.

Shelton (19) virtually proposes a rehabilitation of the abstractions of logic through the medium of the interpretation of mathematical reasoning as involving an essential distinction between the sphere of concept and that of percept. The application of valid conclusions of mathematical reasoning to concrete perceptual existence varies with a number of conditions and may not be complete. This central idea Shelton proposes to carry over into deductive logic. Validity would be limited to conceptual consistency. Two consequences would flow from this identification of logic with mathematics: (1) In the treatment of fallacies the distinction between formal and material becomes important, formal corresponding to errors in the mathematical process, material, a factor more or less implicit in all reasoning, an inexactitude, always present if only to an infinitesimal degree, in the fitting of a conceptual series to a perceptual series. (2) The existential import vanishes. Every proposition is existential in the sense that it implies a concept. The exact meaning or reference to various "universes of discourse" becomes entirely irrelevant to the validity of logical inferences.

The theoretical significance of Mignard's investigation of error (8) lies in its criticism of both intellectualistic and sensationalistic theories of consciousness. The atomistic conception of mind is almost as false as the unitary theory which preceded it. Pathological psychology has contributed to the development of an organic and dynamic psychology. Error, for example, is not the contrary of truth, but the deviation of methods used in arriving at truth.

Werner's genetic study of the concept (20) emphasizes the variety of the sources of concepts. Concepts may arise from feeling or emotional experience as well as from sensory experience, and from kinæsthetic as well as from static sensory experience, or, finally, from the Kantian unity of self-consciousness as *unsinnliche Reflexionsbegriffe*.

Bearing on the question of the existence of pure thought Müller-Freienfels (9) concludes in the negative so far as its existence as a *Gesamtprozess* is concerned. But in specific acts of thinking there may be portions which have no verbal or sensory content, where there is only a vague feeling. This "pure thought" is always a part of some verbal or sensory process—a word, an image, or a gesture.

The plan of the *Encyclopaedie der philosophischen Wissenschaften* (3) is to provide a sort of tribunal for the foremost philosophical thinkers of various nationalities, in the hope that the comparison of the principles here formulated will bring out the elements that are common to all. The first volume of the encyclopedia is given over to six papers on logic written by representatives of as many nationalities. The only paper in the series which develops to any considerable degree the interrelations of psychology and logic is that by Professor Windelband. The mental processes which logic involves need to be analyzed genetically. Truth is a value derived from practical and biological needs. The truth value needs to be studied from the standpoint of social psychology. Yet these scientific studies furnish only the materials not the principles of logic. At this point Professor Windelband falls back in the Kantian position. The principles of logic are to be found, as Kant found them, in the principle of synthesis: logic is the science of reason.

In Royce's contribution to the encyclopedia (3) two fundamental aspects of the logic of absolute idealism, or of absolute pragmatism, as he now seems willing to call it, are developed: (1) the inherence of order, system, in all scientific work, finding expression first in classification, then in comparative and statistical methods, and finally in the complete unity of theory and practice in certain fields of physical science; and (2) the contributions of modern mathematical logic, particularly with reference to the concepts of relationship, series, and class. These are inherent in the very nature of thinking and judgment.

The logical writings of Renouvier (13) have been republished.

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READING

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The amount of investigation in the field of reading continues to be scanty. The literature on the subject since the last report embraces only a few scattered articles.

Schackwitz (3) has described a new form of apparatus for registering eye-movements, which is at once simple and easy of manipulation, though much less precise than the more elaborate photographic methods of Dodge, Dearborn and Judd already in use. The device consists essentially of a delicate tambour which rests on the eyelid and registers the movements of the ball of the eye by the varying pressures as it moves along.

Rothlein (2) has made a rather extensive and careful study of the legibility of different kinds of print, judged by the distance at which the letters can be read both singly and in combination. She finds legibility to vary with (1) the form, (2) the size, (3) heaviness of face, (4) width of margin, (5) position in the letter-group, (6) shape and size of adjacent letters. Of these factors much emphasis is laid on the importance of the heaviness of the face (the thickness of the lines constituting the letters). The most legible of the small letters tested was that form known to printers as News Gothic.

The optimal position for legibility in a group of letters was found to be the beginning; the end of a group comes next, and least advantageous of all is the middle. Letters of the same height or those which are similar in form become relatively less legible when placed side by side, while letters which are dissimilar in form or size become more legible by contrast when juxtaposed.

The quality and texture of the paper are less significant factors for legibility than is sometimes assumed.

Beer (1) accounts for the different psychological impressions made by reading selections having the same content, such as different translations of the Bible, by showing that the reading time varies with the character of the words used. Thus a preponderance of monosyllabic words makes this time relatively long. A detailed study of the speech curves in reading various selections aloud shows also that in those portions where the number of syllables and the number of words is the same or nearly the same the reading time is slower. The proportionally greater time taken under such conditions is to be attributed to the relatively greater meaning conveyed by the monosyllabic words, since in the German it is only the root syllables of the words that are pregnant with meaning.

Weber (4) submits a semi-popular argument in behalf of the view that the faculty of reading is localized in certain groups of cortical centers which vary with the varying types of education. This view is illustrated by reference to a clinical case which does not seem to be of especial significance.

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GRAPHIC FUNCTIONS

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The investigation of handwriting shows an increasing confidence in its ultimate application in the diagnosis of mental traits but, also, an increased sense of the difficulties involved in any attempt at a thoroughgoing analysis of the writing act and its dependence upon conditioning factors.

The controversy between Schneidemühl and Näcke (18) shows certain points at issue. Näcke distinguishes between graphology as interested in character-diagnosis and graphology as a study of graphic signs of service in the identification of handwriting. He admits the latter form only as scientifically significant. Schneidemühl urges a more precise use of the term graphology and emphasizes the fact that handwriting-individuality is determined chiefly by central factors. Schneidemühl's (19) discussion of the diagnosis of character from writing, based upon thirty years' study, summarizes, with certain reservations, the conventional teachings of the graphologists, and gives extensive references to the literature of the subject but with some striking omissions. For instance, in the discussion of mirror-writing no reference appears to Stern's illuminating treatment. The book makes no contribution to the psychological analysis of the writing-act and has suggestive value only because of the wide experience of the author. Rentzsche's (16) caustic criticism seems, on the whole, justified, so ignorant is Schneidemühl of modern psychological analyses.

As an example of the kind of analysis of handwriting that must exist as a presupposition of character-diagnosis one may cite Hirt's (4) valuable discussion. Hirt emphasizes the need of much more empirical work before a psycho-diagnosis from writing shall be

thoroughly grounded. Attention is called to the striking changes in writing known to physicians. From such changes we may determine the fundamental directions in which writing disturbances may appear and so set the problems for a far-reaching scientific investigation of writing. Quite apart from psychical conditions, the writing-act can proceed fitly only if the integrity of the motor apparatus be preserved. Hence (1) it is necessary to study the physiological conditions of writing and to note those cases of pathological writing, as that of the paralytic, that indicate structural changes. (2) The psychophysics of writing would lead us, further, to seek why certain determined mental conditions are correlated with certain peculiarities of action. (3) The psychology of writing also deserves attention, since certain characteristics of pathological writing are independent of physiological conditions. From the physiological side the investigation of writing demands consideration of the general conditions of voluntary movement and of motor coöordination, including the part played in coöordination by visual sensations and sensations from the moving parts. Clinical experience shows that insensitive limbs may be brought under eye-control. Skill once acquired is lost only under certain conditions, as in ataxia. The writing of the ataxic, both with eyes open and eyes closed, merits careful study. The psychophysics of writing involves study of individual variations in both reflex and voluntary movements. Through observation of the tendency to and intensity of movements which a man employs in order to gain a certain end, important conclusions may be drawn relative to his personality. Individual types of behavior are to be sought in the temporal relations of movement; in the writing reaction-types, where the author claims to have found experimentally a sensorial and a motor course; in pressure-types, corresponding to the sensory and motor reaction-types; in rhythmic peculiarities; and in variations in rapidity of writing and in fluctuations in rapidity. Numerous problems are raised, as, for example, the cause of the increase or decrease of writing-size when writing is produced with the eyes closed. With extensive citation of literature, the author yet ignores certain American studies bearing on the topics under consideration.

In attempting to evaluate writing for diagnostic purposes, Hirt distinguishes two possible points of view. One may seek to reach conclusions from handwriting as to the nature of the disease; or one may utilize the change in the writing of a patient of known

disease in confirmation of an already recognized disturbance. Hirt gives a detailed account of the handwriting disturbances found in the writing of the patient with progressive paralysis. In general, the handwriting of the manic-depressive, of the hysterical, and of the patient with catatonia is held to be diagnostically serviceable but, in the majority of the cases, pathological writing is differentiated from handwriting marked by personal peculiarities only by the heightening of such peculiarities.

Klages (8) discusses the meaning and limitations of the concept of handwriting as a type of individual behavior. We may attempt to diagnose character from writing only after a thoroughgoing effort to classify a particular writing with reference to the amount of control exercised in the writing-act. After distinguishing the act of writing from that of drawing, Klages classifies various types of writing as either (1) artificial or (2) natural. Artificial writing includes disguised, calligraphic, and ornamental writing. Under natural or spontaneous writing we get (a) a more controlled and (b) a more involuntary type of writing. Control in writing may arise either from mastery of impulse or from excessive inhibition. Involuntary or uncontrolled writing also shows variations dependent upon acquired traits. It is shown, however, that the concept of an acquired handwriting absolutely inexpressive of the writer's organization is but a limiting notion. Power of disguise or a high degree of sustained control are themselves significant traits. In any case Klages meets the objection that writing-individuality is a matter merely of training and conscious intention.

Köhler (9), in agreement with the majority of observers, finds writing-dreams to be infrequent occurrences and explains this fact on the ground of the complexity of the writing-act.

Attacking the problems of handwriting from a different standpoint, Osborn (15) calls attention to the existence, in various degrees, of form-blindness which operates in rendering the judgments of individuals upon handwriting very uncertain. Tests made on material furnished to Professor Jastrow⁸ by Osborn showed that skill in pairing samples of the writing of the same subject "ranges from 100 per cent. accuracy in eight minutes and thirty-five seconds to 60 per cent. of error in nine minutes and fifty-five seconds. Another subject shows 30 per cent. of error in fifteen minutes and forty seconds." Osborn calls attention to the danger inherent in form-blindness when found in a court of law in one who must decide a question involving handwriting comparison and urges the need of enlarged photographs to increase seeing capacity.

From the pedagogical side the most interesting recent development in the teaching of writing is the insistence upon the value of the utilization of kinaesthetic factors as shown definitely by the experiments of Joteyko and Kipiani (5).

King and Johnson (7) have sought to test the practicability of the Ayres scale by a comparison of the judgments of the same person upon 966 samples of writing to determine whether progression by age and grade appears. The test showed that the scale is really workable. A set of 34 samples graded independently by eight judges showed an average of average deviations of 6.1, less than the 10 points apart of the standard specimens. The one judge gave an average deviation from the average of the eight of only 4.8, "indicating that the ranking of the entire set of 966 by eight judges would not have differed markedly from the ranks assigned by this single judge."

Freeman (2) presents a study of the typical methods of teaching writing in vogue in the United States. The information was gathered by a questionnaire sent to all of the cities of the United States of 50,000 inhabitants or more. Such topics as the following were investigated: slant of writing, type of movement, use of copy-books, time devoted to writing, time of beginning writing, posture, analytic versus the synthetic method, development of form perception and of writing movement, development of speed and accuracy, attainment of rhythm.

Gesell (3) furnishes stimulating suggestions relative to the teaching of writing and drawing in the elementary schools.

Great interest continues to be manifested in the various aspects of the drawing activity. Two tendencies are noticeable, first, a summarizing of previous investigations; and, second, an attempt to formulate a program for an analysis at closer range of the problems involved.

Kretzschmar (10) outlines the main problems and emphasizes their importance for psychology, pedagogy, and the history of culture. Three stages in the general course of development are outlined: (1) the scribbling stage; (2) the ideographic stage in which the memory-image is copied; (3) the physiographic stage in which there is a copying of visual percepts. Kretzschmar insists upon the striking similarities in the art productions of primitive folk and of children and cites with approval Lamprecht's attempt to use children's drawings as an indirect historical source. A study of the child's development in drawing capacity shows that

both invention and imitation are fundamental. The innate impulse to activity is given form by environmental influences. Within the social process of assimilation, can any regularity in development be determined? The answer is affirmative since it is held that the assimilative process stands in intimate union with the growth of the mind itself. Comparative studies of the drawings of children of different races show a similar course of development up to ten years in spite of environmental differences. European children, after that age, pass into a critical stage and either develop into a higher form of activity or stop drawing altogether. Children of primitive races assimilate more quickly the race heritage but often halt at a lower level. The diagnostic value of drawings in pathological cases is cited as particularly instructive.

Rouma's (17) résumé of the literature of the subject and of the investigations that have been made is comprehensive and so systematized as to constitute a valuable reference work. The various methods of study in vogue are reviewed critically. A detailed description, with copious illustrations, of the child's development in portrayal of men and animals is given, together with a citation of the stages in the evolution of the representation of movement, orientation and perspective. Particular attention is paid to the characteristics of the drawings of abnormal children. Rouma is sceptical of any detailed parallelism between the drawings of primitive peoples and the drawings of children because of the profound differences in the conditions under which the two kinds of drawings are produced and criticizes Lamprecht's attempt to utilize the child's drawings in an endeavor to interpret race-development.

Kürbitz (11) furnishes a most interesting and valuable report on the drawings of the mentally sick, a report which confirms in many ways Hirt's discussion of pathological writing. Both spontaneous drawings and reproductions of copy were utilized in the investigation. The author concludes that the drawings of the mentally sick stand in intimate relation to the other clinical behavior of the patient. For this reason it is explicable that there should appear in pathological drawings characteristic differences which are more or less typical of particular mental diseases and have, therefore, a differential-diagnostic value. Further, such drawings show many departures from the normal which are similar to those found in the drawings of children and of the *Naturvölker*, such, for instance, as the drawings partly in profile, partly from the front-view and the so-called transparent drawings in which hidden parts are represented.

Marie (13) cites some examples, with cuts, of stereotypy in the drawings of the mentally diseased.

A comprehensive survey of the art-productions of the *Naturvölker* is contributed by Vierkandt (20). These productions are classified as pure or utilitarian art, with the concession that such a distinction is not always easily made and that primitive drawings may be called art only because of developmental coherence with performances unmistakably artistic. Three types of pure art are discriminated: indicative, representative, and realistic art. The range of objects in indicative drawings is limited largely to animals and men. Mechanical repetition and hybrid combinations appear. There occurs, at times, a mere playing with the intention to designate a particular object. Indicative drawings resemble in many respects the drawings of young children. In representative drawings certain schema keep reappearing; objects are drawn partly from above, partly from in front; invisible parts are represented; localization of parts is often inaccurate; the choice of the subject represented and of the details given is determined by the main interest. In the third type there appears representation of single objects in life-like realistic fashion; the type only, not the individual, is portrayed; claims of perspective begin to be observed; color is often used in a merely playful and meaningless manner.

The aim of utilitarian art is to attain some end to which imitation is used as a means. Such an end may be that of serving some religious purpose, that of communication, or that of ornamentation. The whole course of development shows a gradual change from subjectivity to objectivity. The indicative drawing is almost purely subjective, scarcely more than a fixation of floating ideas. In representative art coherence exists between the object and the drawing but the perception lacks unity. In realistic drawing, true objectivity is achieved.

Luquet (12) and Dück (1) furnish brief contributions. Luquet, from material furnished by the drawings of two children, finds in the first stage of drawing, before an intention is present to represent a special object, three moments: (1) drawing without determined intention; (2) the attribution of meaning to such drawing; (3) the addition of some detail subsequent to the interpretation. Dück finds that at the age of puberty artistic development assumes a different course from that in the preceding period. The natural inclination of pupils for different subjects and for different means of technical expression comes to light at this time. Individual

differences in these respects are very great and related to individual differences in the emotional and perceptive life. The teacher may regulate the individual development but should not attempt to alter the fundamental preferences. Joteyko and Kipiani (6) show the rôle of the muscular sense in drawing.

Meumann (14) furnishes an extensive and suggestive program for the psychological investigation of drawing. Visual, motor, and apperceptive factors should be analyzed in detail. Tests on the estimation of spatial relationships, especially in connection with the well-known optical illusions, should be applied in the investigation of drawing-problems with extension of the work to the testing of children. The photographing of eye-movements during drawing activity and the determination of the child's delicacy in discrimination of kinæsthetic sensation and his difference-threshold for passive and active execution of movements are held to be desirable. Under apperceptive factors, Meumann would consider the influence upon drawing activity of the art-ideals of the nation and of a knowledge of art-technique. It is suggested that an attempt should be made to develop *Einfühlung* processes in the child.

Probably the most significant section of Meumann's article is that which deals with an attempt to determine what, psychically, makes for or against talent for drawing. Theoretically, variation in talent may be dependent upon variation in the following factors: (1) hand-skill; (2) efficiency of visual observation; (3) adequacy and persistence of the visual memory-image; (4) inner power of visual reconstruction; (5) emotional reconstruction of the object portrayed; (6) coördination of the sensory mnemonic processes with hand-activity; (7) various combinations of the above factors.

Only extended observation will show whether all possible theoretic variations actually occur. It has, for instance, been doubted whether a specially high visual capacity with great fidelity of visual memory ever exists unaccompanied by drawing-capacity. Meumann doubts the correctness of such a generalization. Moreover, excellent power of visual observation appears at times to exist without corresponding persistence of visual memory. The relation of efficient memory-images to drawing-efficiency is by no means a simple one. Some painters intentionally permit their visual memories to fade in order to allow details to pass away. Talent for drawing appears to involve, above all, some sort of native visual-motor coördination that may be lacking in individuals of striking visual capacity.

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VOCAL FUNCTIONS

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There is a little known journal which ought to be much more widely used and appreciated by American psychologists. I refer to the *Medizinisch-Pädagogische Monatschrift für die gesamte Sprachheilkunde*. Such a bulky name has perhaps operated as a handicap; and little help has come from the additional words, *mit Einschluss der Hygiene der Stimme in Sprache und Gesang*, with the subtitle, *Internationales Centralblatt für experimentelle Phonetik*. Under the circumstances, it is not surprising that an investigator recently sought in vain to get access to this journal in the Harvard library, and later in the Columbia library. "We are sorry to say we do not have it!" But after twenty-two years of existence under the original name, a new title has at last been adopted: *Vox*. *Vox* says in three letters what three lines have hitherto failed to convey: namely, that this journal is indispensable not only to phoneticians, but also to psychologists, physicists and physiologists who are concerned with the phenomena of voice, as well as to teachers of correct and skilful speech and song who know or care to know the scientific aspects of their task.

The *Med.-Päd. Monatschrift für die gesamte Sprachheilkunde* was founded in 1891 by Albert and Hermann Gutzmann. It is published in Berlin. The editorship now rests with Hermann Gutzmann, director of the speech clinic of the University of Berlin, seconded by G. Panconcelli-Calzia who directs the laboratory of phonetics of the Colonial Institute in Hamburg. Panconcelli-Calzia is primarily responsible for the *Bibliographica Phonetica*, which, with concise annotations, and numerous illustrations of apparatus, has for seven years constituted an important fraction of each volume. Next in bulk come the reviews, literary summaries, addresses, and similar briefer contributions. The more pretentious original articles are few in number, and are sometimes duplicates of papers which appear simultaneously in other journals such as the *Monatschrift für Ohrenheilkunde*.

Three articles from the current volume will receive mention here. One, by the chief editor, H. Gutzmann (6), describes a portable apparatus for experimental phonetics and gives numerous valuable hints as to its use. The apparatus is an adaptation of the

portable recording apparatus made by Zimmermann, which uses long rolls of prepared smoked paper, without drum. It has three recording tambours; including one, of great delicacy, for voice vibrations.

A briefer paper, by the same author (7), describes a simple lecture-demonstration apparatus for producing artificial vowel sounds and for substantiating the Hermann theory—the theory according to which the vowel character is produced, not by selective resonance of partials, but by the actual vibration of the resonance chamber in the period of the fundamental, each vibration actuating the chamber like a separate blast. The apparatus is simply a glass tube with an adjustable piston through which the air comes from a toy whistle. The whistle must be a striking-reed-pipe with a membrane for a reed rather than a metal tongue.

A longer paper by Hugo Stern (12) takes up the old and persistent problem of vocal registers. The investigation was focused primarily upon the vibrations which are induced in the thorax and adjoining organs. The relative extent and intensity of these tremors were determined for different registers and different vowel sounds, as Zimmermann and others had already done for the vibrations of the bones of the head. Vibratory areas were determined by the touch of the hand and by auscultation; and as a control, the areas were also mapped by a deaf and dumb experimenter, with sensitive touch. A comparison of falsetto tones with those of well executed head-tones, and these with chest tones, leads to a suggested modification of the concept of register. By a register is meant a series of tones which are produced not only by the same vibratory mechanism of the vocal cords, by the same position of the cords, and of the larynx, and by a corresponding outgo of air, but also with the same resonance, as exhibited in the gross vibrations of thorax and skull.

Since a cardinal problem of voice training consists in bridging the gap between the registers, Stern urges that, in teaching, attention should be focused on these felt vibrations. Taylor and others are in error who are contending that the sole means of voice training is through the education of the ear and the musical intelligence. The sense of touch, and also the kinesthetic sense of the singer, need to be trained and used. The sensitivity to the movements of the vocal apparatus furnishes the only cue the vocalist possesses for controlling the initiation of sounds: audition can serve as a control only after the voice has begun to sound. In developing this

desired kinesthetic and tactile sensitivity, it is urged that methods must vary with the varying imagery type of the learner.

One of the important addresses at the Berlin congress for experimental psychology was by Alfred Guttmann, on the *Psychophysics of Singing* (4). Bringing to the discussion of his theme the experience of twenty years as singer and teacher, coupled with extended studies in musical history and various branches of musical science, the speaker aimed to point out the interdependence of these overlapping disciplines, and the need for broad equipment in both science and practice if an investigator is to avoid pitfalls. As illustrative, the first typical problem cited was that of tone—"placing." A singer finds that a tone of given intensity has greater "carrying-power" if he "places" it here or there. A physicist may say this is impossible, since sound waves are much too long to be reflected and amplified in such small resonance chambers as those of the head. But a psychologist may reply that direction of attention initiates unconscious sympathetic movements of muscles in larynx and mouth; and these may result in augmenting the capacity of available resonance cavities and altering both quality and volume of tone. With reference to the problem of vocal registers, similar discrepancies between standpoints of physiologist, teacher, and auditor were indicated. In conclusion, the speaker pointed out how the results of Sokolowski (1911) in determining the accuracy of singing the third and the fifth, would not have been invalidated in certain respects, if only the experimenter, in planning his research, had reckoned with the fact that accuracy of singing is diminished in the region of the voice where transition between registers occurs.

Fujita (3) has been studying one of the obscure causes of involuntary variations of the voice, the cardio-pneumatic effect. He finds that the changes in air pressure within the larynx, due to the heart action, can be demonstrated during phonation almost as clearly as during quiet breathing. These pressure variations he finds to amount to as much as from two to five mm. of water. They produce a rhythmical fluctuation of intensity as well as of pitch, and are perceptible by the unaided ear in sounds produced by an unpracticed singer. The effects, which are often unpleasant, are more in evidence the weaker the air pressure, the more nearly exhausted the air in the lungs, and the more difficult the vocal task.

Improvement in the technique of voice measurement continues. The masterful exposition of recording methods given by Poirot in his *Phonetik* (1911) gave prominence to electrical methods. Wert-

heim-Salomonson (15) has supplemented this account with a careful study of the availability of the oscillograph. Different ways of combining oscillograph and stentor-microphone are compared, and the limits of accuracy and the correction factors are determined.

In contrast to the preceding, MacDougall (10) has undertaken not a specific study of a limited problem, but a general account of the development of speech in childhood. In a series of five brief chapters he treats of the instinctive bases of speech, of the imitative process, of the inarticulate expression of affective states out of which articulate speech develops, of words and the acquisition of meaning, and finally of the development of skill in utterance. Broad statements and didactic suggestions are much more in evidence than references to the opinions or achievements of earlier writers.

It is sometimes difficult to draw the line in preparing a summary which is restricted to the field of normal psychology. A strict interpretation excludes reference to studies of speech defects; and no mention is here made of the literature on the cure of aphasia, stuttering and the like, except to call attention to three recent handbooks by Appelt (1), Fröschels (2), and Scripture (11). These are all brief general accounts, not too technical to be of service to the layman. Scripture's little manual on *Stuttering and Lispings*, in particular, is clear and simple without minimizing in any degree the seriousness or the complexity of the practical problem. Most psychologists will be glad to refer to it the many parents and teachers who come seeking information on behalf of afflicted children. Scripture devotes a few brief pages to the psychoanalytic treatment, but avoids the pit into which Appelt falls, of seeking in applications of Freudian methods the main resource for the permanent cure of stuttering.

In conclusion, attention may be called to new editions of Vietor's *Kleine Phonetik* (14), Trausler's *Einführung in die Phonetik* (13), and Gutzmann's *Uebungsbuch* (5); and to an excellent brief introductory text by Jespersen, *Elementarbuch des Phonetik* (9).

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DISCUSSION

THE EFFECT OF CHANGES IN THE GENERAL ILLUMINATION OF THE RETINA UPON ITS SENSITIVITY TO COLOR

The March number of the BULLETIN¹ contains a review by Professor Holt of an article published by Miss Rand entitled: *The Effect of Changes in the General Illumination of the Retina upon its Sensitivity to Color.* Professor Holt says of this article: "Rand's paper is on simultaneous contrast which she calls 'induction.' She finds that 'induction' depends (in positive sense) on the differences between the brightnesses of the adjoining fields, increases with the distance from the fovea, and (within the limits experimented upon) with decrease of illumination. The reviewer does not think that the author's general statement is justified, viz., that a white field adds more black to a patch of color seen on it, than a black field adds white to a similar patch of color; nor does the reviewer see how 'induction' was prevented from affecting the surface which was employed to measure this very 'induction.'" The writer is somewhat at a loss to know what to make of this review. By the most liberal interpretation it can scarcely be considered as representative of Miss Rand's article, which is one of extreme importance, the writer believes, in its bearing on the technique of the investigation of the sensitivity of the retina to color. Moreover, the review is incorrect in statement. The writer asks, therefore, the privilege of making in the BULLETIN the corrections of this review contained in the following pages.²

The work reviewed is, in the first place, not a study of contrast or "induction." It represents a part of a long series of studies carried on in the Bryn Mawr College laboratory to find out all of the factors that influence the sensitivity of the retina to color, and to make a quantitative estimate of these factors. Early in this study the effect of changes in illumination was forced upon our attention. The changes of illumination that took place from day

¹ HOLT, E. B., "Vision—General Phenomena," PSYCHOL. BULL., 1913, 10, 90-91.

² The writer is urged to make these corrections only because of his belief in the importance of this article and its companion article on standardizing to our methods of working in the optics of color.

to day, the progressive changes during the day, and the many sudden changes even in the course of an hour, rendered any constancy or close reproduction of results entirely out of the question. With regard to the effect of changes in illumination on the color observation, two cases may be recognized. (1) When the colored light used to stimulate the retina is independent of the general illumination, *i. e.*, when it is obtained from the spectrum, from monochromatic sources, or from standard filters; and (2) when it is obtained by reflection from pigment surfaces. In the first case the effect is produced through the influence of changes of illumination on the action of the preëxposure and surrounding field; in the second there is added to these effects a change in the amount of colored light coming to the eye. By preëxposure is meant what the eye rests upon immediately preceding its stimulation by color. When the preëxposure is darker than the color, white is added as after-image to the stimulus color; and when it is lighter than the color, black is added. Similarly when the surrounding field is darker than the stimulus color, white is added by contrast; and when lighter, black is added. The effect of these two factors can be eliminated only by working in a light-room, and by choosing as preëxposure and surrounding field a gray of the brightness of the color. But if the general illumination changes, the relation of the brightness of the preëxposure and the surrounding field to the colored stimulus also changes. Standardization for the effect of preëxposure and surrounding field can, therefore, be accomplished only when some means has been devised to maintain the general illumination of the field of vision constant. It was the purpose of Miss Rand in the work reviewed to give an experimental demonstration of this fact. A quantitative estimate was made for pigment stimuli of the effect on the results of the color observation of measured amounts of change of illumination. The following determinations were made. (1) The effect produced by the change in the amount of colored light reflected to the eye; (2) the change produced in the amount of contrast induced by the white and black screens across the gray of the brightness of the colors employed; (3) the effect of these amounts of induction on the limens and limits of color; (4) the amount of change in the brightness relation between stimulus and surrounding field produced by the changes in illumination; (5) the amount of contrast produced by these changes; (6) the effect of these amounts of contrast on the limens and limits of color, etc. True enough, then, a study of the

amount of contrast induced by the surrounding field over the colored stimulus, or rather the change in this amount produced by changes in the general illumination, and the determination of the effect of this induction on the saturation of the color, does become a prominent feature of the work; but to say that the "paper is on contrast which she calls 'induction'" is to mask undeservedly the true purpose of the work. Furthermore, the study was published as a companion article to a description of a method of standardizing the illumination of an optics-room by daylight.¹ In this article a very sensitive method of identifying the illumination of a room by daylight with that of any previous illumination was reported and means of controlling this illumination were described. Results also were given to show that although a large M.V. is obtained in the determination of color sensitivity by the best methods that had been previously used to control illumination, the limens and limits of color can be duplicated within very narrow limits indeed by the method adopted in this work. That is, in our experiments two comparison series of determinations were made. In both all the factors that influence sensitivity to color except change of illumination were eliminated. And with regard to changes in illumination, the best of the precautions that had been used in previous investigations was observed in one series; in the other the illumination was controlled by the method described in the paper referred to. Now of these two articles, although the one on standardization was of primary importance, and the other was contributed only to show the need of standardizing, both the article on standardizing and any reference of the other article to it were completely ignored by Professor Holt either in this review, or any of his reviews representing the year's work in this field.

Further on, Professor Holt says: "The reviewer does not think that the author's general statement is justified, viz., that a white field adds more black to a patch of color seen on it, than a black field adds white to a similar patch of color." In this statement the writer can not help but point out that Miss Rand has been rather badly misquoted. She did not by any means say that "a white field adds more black to a patch of color seen on it, than a black field adds white to a similar patch of color." Taken literally this statement would mean that a white field adds more black to a patch of color than a black field adds white to a similar patch of color

¹ FERREE, C. E., and RAND, G., "An Optics-Room and a Method of Standardizing Its Illumination," *Psychol. Rev.*, 1912, 19, 364-373.

regardless of the brightness relation of the color to the surrounding field. Such a claim would be nonsense and it is not even remotely implied in Miss Rand's article. The statement to which Professor Holt obviously refers occurs on p. 474 of the article criticized as the first item in a general summary of results. It is as follows: "The results show in general the following facts. (1) The amount of induction from the white screen is greater than that from the black screen." This is by no means the broad statement made by Professor Holt. Nor is his statement justified by the context. The range of application of the statement criticized is, in fact, limited by its context. It is an item in summary, not a general conclusion. Moreover, it is specifically stated that the summary is intended to apply only to the tables published. In these tables is given the amount of induction of white and black screens on grays of the brightnesses of the four standard Hering colors: yellow, green, red, and blue. This induction was measured at 25° and at 40° in the temporal meridian on the grays of the brightness of each of these four colors as seen at these points both under the illumination selected as standard and at a fixed illumination less than the standard.¹ A survey of the results shows the following facts. Of the 32 measurements of induction recorded in Table I., three exceptions occur to the general statement made by Miss Rand. For example, in Column 2, row 7, the induction from the white screen at 40° on gray No. 24 (gray of the brightness of red as seen

¹ Measurements were also made at 55° and 70° on the nasal meridian. The conditions at the nasal 55° point were very similar to those at 25° on the temporal side. The measurements at 70° nasal were midway in value between those at 25° and 40° on the temporal. The 40° point is very near the limits of color sensitivity in this meridian, and the induction here is very great. For one observer the darker stimuli appeared black at this point when the white background was used. In such cases the difference between the induction at standard and at decreased illumination is more clearly shown by the observations made at 25° temporal meridian and at 55° and 70° nasal meridian than at 40° temporal. Miss Rand chose, however, for two reasons to present in her tables only the results obtained in the temporal meridian. (1) The results obtained in this meridian demonstrate sufficiently well all the facts that need be taken into consideration. Space was not, therefore, taken for the results for both meridians. (2) The second point of her problem required her to correlate the increased amount of induction caused by a given decrease of illumination with the change in the color limits it produced. The limits of color sensitivity can be more easily investigated in the temporal meridian because the sensitivity to some colors extends in the nasal region beyond the 92° point, which is the limit of measurement for the apparatus she used. This was true in particular in case of one observer (C) as may be seen on p. 482 of her article, Table XI. Both purposes of the investigation were, then, better satisfied by the results obtained in the temporal meridian.

at this point) is given as 0° black; and that for the black screen as 60° white. A comparison of the printed table with the manuscript shows that this is a typographical error. The measuring-disc to match the stimulus acted upon by the surrounding white field should have been recorded here as containing 360° black. (2) In Column 2, row 5, the induction of the white screen over gray No. 2 at 40° is given as 200° of black at standard illumination and that from the black screen as 300° of white. (3) In the same row, Column 4, we find that for decreased illumination the measuring-disc recording the induction from the white screen on gray No. 2 contains 320° of black; that for the black screen 360° of white. There are in reality, then, out of 32 items, only two exceptions to the general statement made by Miss Rand, and these two occur for gray No. 2, which is only one gradation removed from the Hering white, and is at least 48 gradations removed from the Hering black. In Table II. for Observer C out of 32 items of measurement four exceptions are found. These are again at the 40° point and in case of the grays near to white: gray No. 2, the gray of the brightness of yellow at standard illumination; gray No. 3, the gray of the brightness of yellow at the decreased illumination; gray No. 7, the gray of the brightness of green at standard illumination; and gray No. 4, the gray of the brightness of green at the decreased illumination. Thus not only has Miss Rand not stated that a white field adds more black to a patch of color seen on it than a black field adds white to a similar patch of color, but she has not even stated that a white field adds more black to a color equally removed in brightness from black and white, than a black field adds white, although this conclusion might very well have been drawn from her results. She has merely stated in summary of her tables that at the points of the retina examined and with the illumination employed, more black was in general induced by white over the grays used as stimuli, than white was induced by black. There was no attempt, for example, to contradict the well-established law of brightness contrast for the central retina, namely, that the amount of induction in general sustains a relation to the amount of brightness difference between the inducing and the contrast surfaces. Instead this law was enlarged upon and its application was extended to the peripheral retina. For example, in items (2) and (5) of the same summary from which Professor Holt gets his material for criticism, she says (2) that the amount of induction increases with the distance from the fovea; and (5) that the white and black screens induce

more contrast across the stimuli that are farthest removed from them in brightness and least across those which are most like them. The present writer thinks, then, that Professor Holt's criticism at this point is not at all justified. He has in fact in the first place through some oversight misquoted Miss Rand's article, and in the second place he has failed to see that the statement made by Miss Rand, qualified as it is by its own formulation and by the other items of summary, is amply borne out by the results of her tables. Apparently one ground alone, therefore, could remain for criticism, namely, to question the accuracy of her tables. It would not, the present writer believes, be like Professor Holt to do this without citing the results of similar experiments to support his criticism.

Professor Holt finally states: "Nor does the reviewer see how induction was prevented from affecting the surface which was employed to measure this induction." A brief résumé of the conditions under which the measurement was made will probably best introduce our reply to this criticism. The gray surface over which the contrast was to be induced was exposed through the opening of the campimeter screen.¹ This opening was of the same magnitude as was ordinarily used in our color work, namely, 15 mm. in diameter. The amount of induction was estimated upon a measuring-disc made up of adjustable sectors of the gray of the stimulus and white or black, according to the screen used. The measuring-disc was mounted on a motor which could be moved along the graded arm of the campimeter to any position from 20°-92°. The fixation-point was placed directly in front of the measuring-disc and as far from its edge as conditions would permit. The surface of the measuring-disc projected approximately an inch in front of the campimeter screen. Now with regard to whether or not contrast was induced over the measuring-disc by the campimeter screen, the writer would say in the first place that for Miss Rand's purpose it would have been of little consequence whether or not contrast was induced, so long as it was small in amount as compared with that which was induced over the stimulus. But we can go further than this, and say that if contrast were induced it was in amount less than noticeable, for a comparison of her measuring-disc with a disc made up of similar sectors surrounded by a field of its own brightness showed no noticeable difference in the brightness of the two. This was probably due to the following reasons.

¹ For a description of the apparatus used, see FERREE, C. E., "Description of a Rotary Campimeter," *Amer. Jour. of Psychol.*, 1912, 23, 449-453.

(a) The measuring-disc was made as large as could be used on the apparatus. There was, then, a big area over which to induce. (b) It projected almost an inch in front of the campimeter screen. Since the observing eye was only 25 cm. in front of the screen, it can be readily seen that this gave very unfavorable conditions for contrast. Added to this was the fact that the edges of the disc and their supporting back, even in case of the most careful cutting, made contrast-eliminating margins, especially when the surface of the disc was viewed somewhat obliquely by an eye only 25 cm. distant. The big difference, of course, in the conditions affecting stimulus and measuring-disc was that the image of the former fell on the peripheral retina which is extremely sensitive to brightness contrast, in part because of its low illumination; and the image of the latter fell on the central retina which is comparatively insensitive to contrast. In any event whether or not the above is a complete analysis of the conditions affecting the experiments, a noticeable amount of contrast was not induced over the measuring-disc. Moreover, that was scarcely the point at issue in her work. She was trying to find the effect of change of illumination on the induction of the surrounding field over the stimulus. The real question, then, is not whether contrast was induced on the measuring-disc by the surrounding field, but rather whether there was any change in the amount of this induction produced by changes of illumination. This point is more difficult to determine directly than the other. But we can say this. This apparatus has been used for three years by us to detect changes in the illumination of our optics-room. The principle upon which this detection is based is that if measuring-disc and stimulus are made to match for a given illumination, a change in the illumination causes the match to be disturbed. That is, when a white screen is used, the stimulus becomes darker than the measuring-disc if the illumination decreases. Whether or not the measuring-disc also is darkened by contrast to any considerable extent can be judged by the sensitivity of the method for detecting changes in illumination. This sensitivity was compared, for example, with that of the Sharpe-Millar portable photometer. The comparison was made in our optics-room at a degree of illumination at which the test was made (390 foot-candles). The optics-room is on the fifth floor of an isolated building and is illuminated by a skylight beneath which are swung diffusion sashes of ground glass. The illumination of this room is varied by means of a series of curtains varying in opacity from a very thin white curtain to a

light-proof black curtain. By our method a change could be detected which was produced by pulling the white curtain 1 cm. from a position in which its edge was directly above the long axis of the campimeter. But with the receiving surface of the portable photometer in precisely the same position as the stimulus screen of the campimeter, the edge of the curtain had to be moved 11.3 cm. in order that the change of illumination might be detected. Moreover, this amount of change could be detected only in case the photometric field was continuously observed while the curtain was being drawn, in which case the comparison field was observed to become slightly darkened. The judgment was made, then, in terms of a just noticeably different brightness of the field which was illuminated by the daylight, rather than in terms of a disturbance in the brightness-equality of the two fields. When, on the other hand, the judgment was made in terms of a just noticeable disturbance in the equality of the two fields, as the judgment would have to be made if the photometer were to be employed for the reproduction of any former illumination taken as standard, the curtain had to be drawn 44.2 cm. before the change could be detected. This j.n.d. represents an amount of illumination equal to 2.5 foot-candles. But the Sharpe-Millar photometer is insensitive for daylight work. In this photometer one of the comparison fields is illuminated by the light of the room and the other by a standard tungsten lamp enclosed in the photometer box. When the room is illuminated by daylight, the field receiving the light of the room is seen as white, while the field lighted by the tungsten lamp appears as a saturated orange. The difference in color between the two fields renders the photometric judgment difficult and renders the instrument, as is stated above, insensitive for daylight tests. However, we have supplemented this comparison by one that gives a fairer evaluation of the sensitivity of our own method. At the request of certain physicists who have become familiar with the method as used in daylight work, we are now working it out in a form that will apply to the regular work of photometring artificial lights. That is, the campimeter screen and measuring-disc are used in connection with a photometer bar which carries in turn the standard and comparison light. Our work so far shows that the method possesses for colorless light as much, if not more, sensitivity as the best Lummer-Brodhun photometer, for example, and has the advantage besides of simplicity and cheapness of construction. It is in color photometry, however, that it

possesses, comparatively speaking, its greatest advantages. It gives us a highly sensitive method of direct comparison more accurate, as will be shown in a later paper, than the flicker method. It is obvious, then, from the results of this photometric work in which the method is used of matching or measuring the amount of contrast induced in the peripheral retina by the surrounding field over the stimulus, that the measuring-disc can be affected little, if at all, by changes in the inductive action of the surrounding field produced by changes in the illumination of the room, else such small changes in this illumination could not be detected by the method.

C. E. FERREE

BRYN MAWR COLLEGE

THE HIPP CHRONOSCOPE WITHOUT SPRINGS

In reference to Dr. Max Meyer's remarks¹ concerning my method of using the Hipp chronoscope, I have at present the following to say: First. My method cannot properly be designated an attempt, in view of the fact that one of my students has completed by this method a set of 37,000 reactions. Daily pendulum checks of the chronoscope during this work revealed an extreme variation in the chronoscope readings during the year (due to temperature changes) of less than five sigma on a normal time of one hundred and fifty-eight sigma, and a mean variation on any given day always less than one sigma, which means practically absolute accuracy. Second. I have not tested Schultze's modification of the Hipp, but from long experience with induction currents I feel safe in saying that, in the hands of an expert, serious constant errors might be avoided (these errors would not be revealed by ordinary methods of checking); but that variable errors are practically unavoidable, since the intensity of the induced current varies greatly with the speed of the break of the primary circuit. For accurate operation, it is essential that the starting and stopping currents be of equal intensity: this condition may be uniformly maintained by a pendulum or other control instrument, but not in actual reaction timing, where the stopping current is produced by the reactor's break of the primary circuit. Third. Leaving out of account the high degree of proficiency in electrophysics required for the operation of the Schultze-Hipp, and the unavoidable variable error, I recommend my method, because it may be used with the ordinary Hipp with which most laboratories are provided.

¹ See March BULLETIN, p. 122.

If the reed of the chronoscope is adjusted for the right rate at a given temperature, and the same circuits are used in checking the chronoscope and in the actual reaction timing, when the chronoscope is once properly checked no further checks need be made so long as the set-up is not changed, and the temperature of the chronoscope room is maintained approximately at the normal.

KNIGHT DUNLAP

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THE EFFECT OF VERBAL SUGGESTION ON THE AFFECTIVE VALUES OF COLORS

In the BULLETIN for July 15, 1913, Professor Scott reviews Minor Study Number XXI from the Psychological Laboratory of Vassar College, which appeared in *The American Journal of Psychology* for April, 1913. The writer of that study, while appreciating the courteous tone of the review, feels impelled to make a few statements in reply. In the first place, she acknowledges the justice of the criticism that the article should have given information as to the prestige of the experimenter. The experiments were as a matter of fact conducted throughout by Miss I. Powelson, a fellow student of the observers, who did not in their eyes have any especial prestige as a judge of the affective values of colors. Secondly, to Professor Scott's criticism that "no statement is made as to the variability of the original results," it should be replied that the mean variations of our averages were without bearing on our main problem. All kinds of causes produce fluctuations in judgments of the affective value of colors; what we sought was the expression of a constant tendency which, if it existed, would appear in the averages which we compared. The criticism cannot mean that the results of individual observers were not separately treated, since they were so treated throughout. Thirdly, Professor Scott says that there was no statement "of the standardization of the conditions under which the experiments were performed." Here we feel that we have a grievance against him. He quotes as our description of our method a single sentence, describing the formula by which the suggestions were given. He omits our description of the following further conditions: the length of the series of colors, the size of the colored areas, the nature of the background, the fact that the same order of presentation of the colors was always followed, the fact that the experiment was performed twice on each subject, with an

interval of several days, unfavorable suggestions being given in one sitting and favorable ones in the other; the fact that for half of the observers the series with unfavorable suggestions was given first, while for the other half the order was reversed; and the precautions which were taken to show that any raising or lowering of affective values that occurred was really the result of suggestion and not of other causes. Space of course forbade him to give so detailed an account of our method, but he should not have suggested to the reader that we had omitted all details but the single one he quotes. Finally, we did not share Professor Scott's surprise at the comparative infrequency of the positive effects of suggestion in our results. Direct verbal suggestion is usually the least effective form. In many observers it stirs up so strong a reaction of opposition that it works negatively. Personally, I should not have been surprised if the large majority of our observers had found the colors less pleasant under suggestions of pleasantness, and *vice versa*. Perhaps this is a sex difference?

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